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Validation of the ICU-DaMa tool for automatically extracting variables for minimum dataset and quality indicators: The importance of data quality assessment

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ABSTRACT

Background: Big data analytics promise insights into healthcare processes and management, improving outcomes while reducing costs. However, data quality is a major challenge for reliable results. Business process discovery techniques and an associated data model were used to develop data management tool, ICU-DaMa, for extracting variables essential for overseeing the quality of care in the intensive care unit (ICU).

Objective: To determine the feasibility of using ICU-DaMa to automatically extract variables for the minimum dataset and ICU quality indicators from the clinical information system (CIS).

Methods: The Wilcoxon signed-rank test and Fisher's exact test were used to compare the values extracted from the CIS with ICU-DaMa for 25 variables from all patients attended in a polyvalent ICU during a two-month period against the gold standard of values manually extracted by two trained physicians. Discrepancies with the gold standard were classified into plausibility, conformance, and completeness errors.

Results: Data from 149 patients were included. Although there were no significant differences between the automatic method and the manual method, we detected differences in values for five variables, including one plausibility error and two conformance and completeness errors. Plausibility: 1) *Sex*, ICU-DaMa incorrectly classified one male patient as female (error generated by the Hospital's Admissions Department). Conformance: 2) *Reason for isolation*, ICU-DaMa failed to detect a human error in which a professional misclassified a patient's isolation. 3) *Brain death*, ICU-DaMa failed to detect another human error in which a professional likely entered two mutually exclusive values related to the death of the patient (brain death and controlled donation after circulatory death). Completeness: 4) *Destination at ICU discharge*, ICU-DaMa incorrectly classified two patients due to a professional failing to fill out the patient discharge form when thepatients died. 5) *Length of continuous renal replacement therapy*, data were missing for one patient because the CRRT device was not connected to the CIS.

Conclusions: Automatic generation of minimum dataset and ICU quality indicators using ICU-DaMa is feasible.

Abbreviations: ICU, Intensive care medicine; EMR, electronic medical record; CIS, Clinical information systems; ICU-DaMa, Intensive Care Unit Data Management; CRRT, Continuous renal replacement therapy; SNOMED-CT, Systematized Nomenclature of Medicine–Clinical Terms; SEMICYUC, Spanish Society of Critical Care Medicine and Coronary Units

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The discrepancies were identified and can be corrected by improving CIS ergonomics, training healthcare professionals in the culture of the quality of information, and using tools for detecting and correcting data errors.

1. Introduction

Clinical data obtained from patients are a source of progress and knowledge [1]. The electronic medical record (EMR) can help ensure quality care, improving patient safety and outcomes while reducing costs [2,3]. Intensive care units (ICU) are data intensive environments. Clinical information systems (CIS) make it possible to integrate patient data from bedside monitors and process-of-care information registered by healthcare professionals, offering advantages in the efficiency and quality of care [4,5].

Health systems have prioritized quality of healthcare for decades, and transparency is becoming the norm [6,7]. Currently, a large proportion of the data required to measure quality is collected manually, consuming significant human resources [8] and generating dissatisfaction among healthcare professionals [9]. Health organizations and professionals have high expectations that new electronic data sources and analytical methods will provide answers to questions that cannot be examined using traditional registries for quality assessment and controlled clinical trials [10].

National and international EMR-based clinical research networks are expanding the scope and depth of available data to answer critical questions about care decisions and outcomes [11]. The extraction of clinical and administrative information from the CIS leaves much to be desired [12], although important steps have been taken to enable EMRs to be used as a platform for building quality standards and metrics [13–15]. In intensive care medicine, there is a broad consensus about the minimum dataset to record, and a set of quality indicators has been defined [16]. However, before an integrated service platform can be developed to use data from the CIS for clinical management, benchmarking, and research networks, it is essential to ensure the quality of the data collected and analyzed [17]. We aimed to determine the feasibility of generating quality metrics in the ICU with a data management tool.

2. Methods

2.1. Study design

We compared the minimum dataset and quality metrics generated automatically by our ICU data management tool for our ICU during a two–month period against gold standard values extracted from our CIS by physicians. The minimum dataset is the variables that organizations need to collect to ensure consistent, unified information for benchmarking and quality assurance purposes.

2.2. Patients

We included all non-coronary patients attended in our 30-bed polyvalent ICU during the period comprising September 1 through October 31, 2016; we did not include coronary patients because they are attended by other specialists.

All patients or their legal representatives provided written informed consent, and our center's research ethics committee approved the study protocol (CEIC *Institut* d'Investigació *Sanitària Pere Virgili.* Reference: 41/2016).

2.3. Description of the clinical information system

Our ICU uses a commercial CIS (Centricity™ Critical Care Suite, GE Healthcare) configured by the work team and integrated with the EMR, with all bedside equipment, and with other software from the admissions department, laboratory, and radiology department. ICU

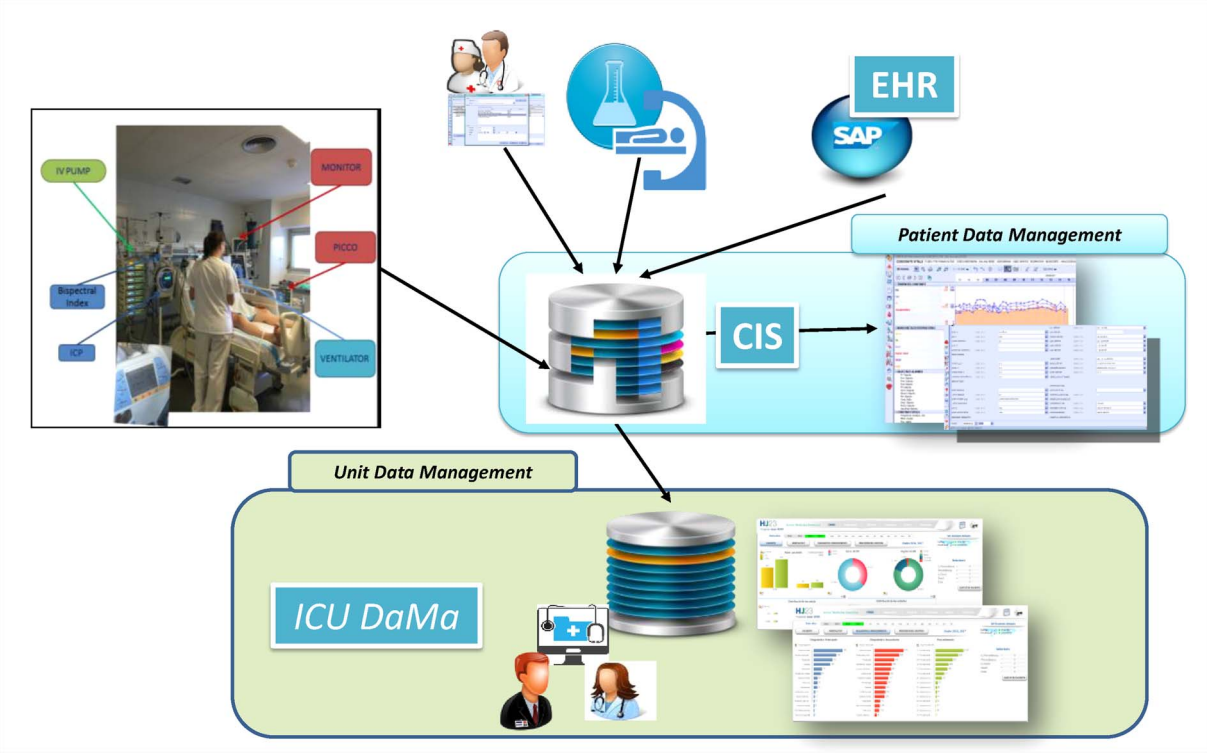

Fig. 1. Flow of the data. Relationship between the CIS and ICU-DaMa.